13 JUL. 1926
ENTOM.
U. P. COLL. OF AGRICULTURE
LIBRARY

The Philippine Agriculturist and Forester

Twenty-five Centavos a Copy
Two Pesos a Year

Foreign Subscription:
1.50 Dollars a Year

Vol. III. 1914 No. 3.

CONTENTS

	Page
Improvement of Sesamum - - - -	51
Use of Fertilizers - - - - - - - -	64
Student Body Activities - - - - - -	68
Alumni Association - - - - - - - -	68
Fertilizing Sugar Cane- - - - - - -	69
Current Literature - - - - - - - -	73

PUBLISHED BY

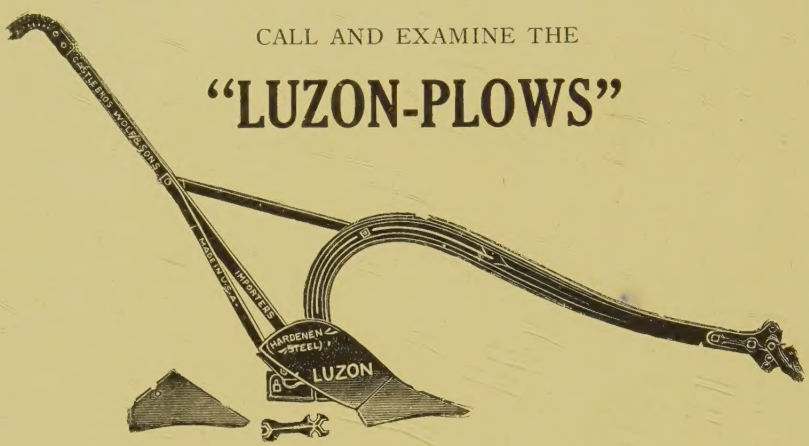
The Student Body of the College of Agriculture

Los Baños, Philippines

"THE MAN WHO FEEDS THE NATION IS THE MAN BEHIND THE PLOW"

CALL AND EXAMINE THE

"LUZON-PLOWS"



ALSO THE

"LUZON-LAGIO"

AT OUR DISPLAY ROOM

Years of study have been devoted to the perfection of these Plows to meet conditions in the Philippines, as is evidenced by the fact that the "LUZON" and "LUZON-LAGIO" are now the accepted standard and are to be seen in all parts of the Archipelago.

WE ALSO CARRY IN STOCK:

HARROWS, CULTIVATORS, MOWERS, WAGONS, BULL CARTS, CORN GRINDERS, CORN SHELLERS, STUMP PULLERS, ETC.

PACIFIC COMMERCIAL COMPANY

ILOILO - MANILA - CEBU

Engineering and Machinery Dept. **No. 2 Isla de Romero, Sta. Cruz, Manila**

The Philippine Agriculturist and Forester

Twenty-five Centavos a Copy
Two Pesos a Year

Foreign Subscription: 1.50 Dollars a Year

Vol. III 1914 No. 3

Improvement of Sesamum

By Eutiquio Quejano Zulaybar

Thesis presented for graduation from the College of Agriculture No. 23

INTRODUCTION

In the Philippine Islands Sesamum is used in the manufacture of native sweet-meats and bread and to a small extent for its oil. Although of but limited use here, it plays an important part in the industry of some other countries, like France, where the oil is extracted and used in soap making, in the manufacture of perfume, and in various other ways. There is every reason why the plant should be studied in the Philippines, and attempts made to improve it and its culture.

The sesamum which is imported into Europe mostly comes from the Orient[1], India being the principal source. The exportation of sesamum from India[1] is on the average 120,000 tons each year. It varies in value, according to the variety, from 30 to 38 francs per 100 kilos.

As this country grows and as its business improves both internally and externally, there is every reason to believe that the demand for sesamum will be proportionally greater and greater, and an early study for the purpose of bringing it to its maximum production in the most economical way should certainly be beneficial.

Considering the importance of this work in the improvement of crops, a large amount of valuable help can be expected from it. The improvement of plants by means of selection depends of course upon variation; therefore it is a first necessity to know how sesamum plants vary, inherently.

For many years sesamum has been raised in various parts of the islands, especially in Pampanga[2], Pangasinan, Tarlac, etc., but, as in the case of most of our principal crops, no systematic selection has been practised in those places.

Sesamum[3] has long been cultivated in tropical countries for the oil extracted from the seed.

Because of the large number of species there, it is believed by some that it had its origin in Africa. But the fact that this plant is also extensively cultivated in the South of Asia raises some doubt. It is found also in the Sunda Isles, Egypt, etc.

"Blume, a trustworthy observer, mentions a variety with redder flowers than usual, growing in the mountains of Java. He thinks that Java is the original habitat, but this evidence is not enough to prove it."[3]

Sesamum has long been cultivated in Asia, but may or may not be a native there. It is called in Sanskrit *tila;* in Malay, *widjii;* in Chinese, *moa* or *chima;* in Japanese, *koba.* The name "sesame" is known in many countries. The first mention of it was in books of the fifth and sixth centuries, B. C. Before this time its history is doubtful. Herodotus (I, 193) says the only oil used by the people of Babylonia is that produced by sesame.

Theophrastus and Dioscorides mention this plant as cultivated in Egypt, where it was called sesame, and where oil was extracted from it. At the same time Pliny said that it came from India.

There was no definite proof that it originated in Egypt because nobody mentioned that it was cultivated there before the time of Theophrastus; and besides no mention was made of it in the books of the Hebrews.

It is suppposed that the Semitic people carried it to Egypt because the word *semsem* is a semitic word.

This plant was very early cultivated in the Euphrates valley where it was known by the name *tila.* To the word *tila* may be traced some names now found in several modern languages of India and Ceylon. Several authorities have agreed that the place of origin of the plant is the Sunda Isles from which it was introduced into Ceylon and India and from there carried through the Euphrates valley to Egypt.

The present work has been done for the purpose of determining what effects selection has upon the yield of the plant, and to isolate some of the forms of sesamum that might come as a result of variation or breeding. The selection, of course, embraced the matter of increase of yield per acre or per hectare. Recognizing the importance of this principle, productiveness is made the first basis of this selection.

Origin of Seeds

The seeds were furnished by the Agronomy department of the College of Agriculture. With the college number, variety names and origin, they are shown on the following table:

College number.	*Color*	*Origin.*
404.....	White.....	Japan.
403-F_1....	Black.....	Japan.
1622.....	White.....	Burma.
326-F_1...	Black.....	Phil. Exp. 1912.
413.....	Reddish white.	Phil. Exp. 1912.

Variety Culture

This experiment was begun on the 21st of April, 1913. Different varieties were planted in separate plots so that it might be absolutely sure that there would be no mixture among the varieties. They were planted in one-half plot of 4×12.5 meters whit hte exception of 403-F_1; this variety was planted in three rows of the same size of plot because of the small quantity of seeds available.

The soil used for this experiment was clay-loam, which is typical of the soil of the College farm. For about two years it had be n planted with

common garden plants, but the last crop was tobacco fertilized with stable manure and wood ash.

Soil

Th ground for this plant should be at least 1 foot in depth on account of the long tap-root. The ground must be pulverized well so that the roots of the plants can easily penetrate it. It is a common observation that the better the soil and the more thoroughly it is pulverized, the better the crop. In order to accomplish this the plow should be followed by the disk harrow and then by the smoothing harrow.

Sesamum is a plant which is very susceptible to its environment. The soil which seems to suit it most, is a loam or a rich sandy loam, containing enough moisture.

Fuller[5] says: "It can be grown on almost the poorest land in cultivation, but is also a profitable crop on good soils and is commonly sown on newly broken lands during the first two years of the reclamation."

According to Roy, the best soil is an alluvial loam, high and well drained.

Planting

The methods in planting differ in various places. In some places the seed are planted broadcast, but this method renders the field very difficult to weed. In other places the seed are planted in rows. This method is the best of those tried in the present cultures. The advantage of this method is that it permits of easy cultivation and at the same time does not waste too much seed.

Cultivation

When the plants are about four inches high, they may be thinned to 5 to 10 centimeters apart. In field cultures they should be planted at about the right distance in the beginning. This depends of course upon the variety. Larger varieties need a wider space. In small cultures, where vacant places occur in the rows because of failure to germinate, replantings may be made. The land on which this crop is planted must be kept free from weeds.

The first cultivating may be done when the plants are about 5 centimeters high. It cannot be done while they are small as the plants are tender and very delicate.

Description of Varieties

During the culture of these different varieties, one can easily recognize their differences from one another by their leaves, capsules and the duration of time from sowing to maturity. Some are early varieties and others are late varieties as indicated on the following table:

College Number	*Date of sowing* 1913	*Date of germination* 1913	*Germination test No. of days*	*Number of days from sowing to maturity.*
404-F_1	April 30	May 3-6	6	43
403-F_2	May 15	May 18-20	6	47
326-F_2	April 25	April 28-30	6	96
1622-F_1	May 15	May 18-20	6	83
413-F_1	June 11	June 14-16	6	118

From the above table, it seems that 404-F_1 and 403-F_2 are early varieties and the latest variety is 413-F_1. The early varieties are preferable as they take but a little time and therefore save labor.

Variety 404-F_1 (White).

This variety is low and one of the earliest varieties. The leaves are small. It grows as high as 80 centimeters and resists disease fairly well. The capsules have a medium size with a medium pubescence.

Variety 403-F_2 (Black).

Plants of medium size. Foliage of medium size with many leaves to the plant. Generally they produce a single stem. The capsules are rather large, tending to become somewhat globular, and with irregular locules. The capsules are provided with a medium pubescence.

Variety 1622-F_1 (white).

The plants are rather tall, growing as high as 180 centimeters. They generally bear many branches. The foliage is large. The capsules are medium in size with silky pubescence. This variety is very productive, and will be promising as a commercial variety.

Variety 326-F_2 (black).

The plants are rather large and have many branches. They grow as high as 200 cm. The leaves are large. The capsules are medium in size with silky pubescence.

Variety 413-F_1 (Reddish white).

The plants are of large size and vigorous. They have foliage of large size. The leaf stalks are rather long and slender. The capsules are medium in size and with irregular locules. They are surrounded with fine hair. This is a late variety and quite susceptible to disease.

Enemies

Several diseases, both insect and fungus, appeared during the experiment. The most common insects were leaf rollers. They eat the young leaves of the plant. These generally occur on the small plants.

There were two fungus diseases observed. They were dumping-off fungus, and a leaf spot caused by *Cercospora Sesami* A. Zimm. The damping-off fungus generally occurred in rainy weather, and when the plants were crowded. It attacked only the small plants. *Cercospora Sesami* A. Zimm. attacked the leaves only, and eventually caused them to fall.

Harvesting

Harvesting is very easy and simple. The sickle and bolo are the implements commonly used. The stem is cut close to the ground. The cut stems are piled up and tied into bundles. The smaller the bundles the better will be the drying. Immediately after they are brought to the drying house, they can be spread on a mat. They are dried there till all the capsules are opened and the seeds can be shaken out.

However, different places have different methods of harvesting. In Egypt[5] the stems are not cut but pulled up by hand to avoid a loss of seed by breaking, shaking, etc. Care should be taken in shaking the bundles because many seeds are lost by careless shaking. When the seeds have mostly fallen out, the capsules are separated from the stalks and put into sacks and beaten with a heavy piece of wood to separate the rest of the seeds. Simple types of threshers would be far more effective than hand work.

The length of drying depends upon the weather; the more sunny the day the more easily the capsules open. It usually takes about six days to separate the seeds from the capsules in dry weather, and almost double that in rainy weather.

Market Value

The price of sesamum differs in different places and also according to the variety. In Tarlac[6] (Philippines)

the white variety sells at 30 to 40 centavos per ganta (3 liters) and the black at 25-30 centavos. In Indo-China[2] also the cost of white grains is greater than of black. This is because the latter cannot, on account of their color, be used for confections or pastries, while the white grains can be.

Use of Sesamum Seeds

There are several uses of sesamum in these Islands which have already been referred to.

In Marseilles where two-thirds of the sesamum production of the world is imported, the seeds are all extracted for oil. There are many uses for this oil. It is largely used for making soap, in perfume, and for burning in lamps.

In Egypt[6] the sesamum seeds are expressed by cold pressure, the oil to be used for food. It is used as a substitute for olive oil. It is also extensively used in cookery, in confectionery, pharmacy, etc. The oil of low quality is used for soap making, lubricating, burning, etc. During the process of pressing, another by-product is obtained besides the oil. It is the sesamum cake, which is eaten by the poorer classes in Egypt as food, and in various places is fed to cattle.

It has been observed that sesame cake has a great influence upon the butter and fat of dairy cows. "An experiment was made by Annato to determine the influence of sesame cake upon this butter and fat. He fed three cows increasing the amount of sesame cake from two to five pounds, and examined the resulting milk. In the third period sesame oil was found in the milk by the furfurol reaction. From the result obtained, the conclusion is drawn that the presence of sesame oil in butter from cows fed on sesame cake is not necessarily an adulteration."

Preservation of Seeds

When the seeds are cleaned they should be stored where they will be free from insects and where they will be dry. In Tarlac they put the seeds in earthen jars with some wood-ash and cover it with cloth tied tightly over the mouth of the jar.

When the seeds are to be used for food they may be put in the seed-storing can or jar, provided the cover is well fitted to the mouth so that insects can not enter.

Selection of Sesamum Plants

Before the harvesting of each variety in the present experiments, selection was first made in the field. This was done because here one can easily see what he desires. All the plants that seemed strong and vigorous, where this did not appear to be due to the ground and hence to the amount of plant food available, and those which showed the greatest number of capsules, were marked with colored string.

During the selection of plants in all the plots of different varieties, several variations were noted in 403-F_1, in the number of locules to the capsule. The locules ran as high as 10. There also appeared to be two distinct types in this same variety—one heavily pubescent, the other slightly so. Among the latter occurred a much branched form, very different from the general type. All of those that showed peculiar characters were separated and carefully labeled. At the harvest time all of the capsules were separated in groups depending on the number of locules.

After a few days' drying the seeds were separated from the capsules and then cleaned by hand. After cleaning, they were carefully weighed separately, the figures obtained are shown in the following table:

SELECTION I.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Ave. Wt. gm.*	*Seeds. Weight gm.*	*Branches*
404-F_1							
I-a-I	66.7	29	2	2.9×1.0	0.13	3.90	2
I-b-II	71.6	21	2	2.8×0.9	0.15	3.12	2
I-c-III	68.6	32	2	2.9×0.9	0.13	4.09	2
I-d-IV	67.2	25	2	2.8×0.9	0.12	2.90	4

All have scant, small leaves, medium vestiture, yellowish green trunk, greenish black capsules. All are very susceptible to leaf spot. Weather, rainy.

SELECTION I.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Ave. Wt. gm.*	*Seeds. Weight gm.*	*Branches*
1622-F_1							
I-a-I	17.6	262	2-4	2.6×1.0	0.06	14.55	10
I-b-II	18.5	140	2-4	2.3×1.2	0.01	1.25	12
I-c-III	16.0	142	2-4	2.3×1.0	0.07	9.50	9
I-d-IV	20.2	79	2-4	2.5×1.0	0.05	3.70	7

Leaves: I-a-I, abundant, large; I-b-II, abundant, medium; the rest, scant, small. All have smooth vestiture and are very susceptible to leaf spot except I-d-IV which is only slightly so. The capsules when ripe are greenish black, and the trunk, yellowish green. Weather, rainy.

SELECTION I.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Ave. Wt. gm.*	*Seeds. Weight gm.*	*Branches*
326-F_2							
I-a-I	212.0	130	2	2.5×0.8	0.11	13.7	11
I-b-II	208.0	130	2	2.5×0.8	0.14	18.15	16
I-c-III	189.0	214	2	2.7×0.8	0.05	10.5	8
I-d-IV	224.8	98	2	2.5×0.8	0.11	14.5	10

Leaves: I-a-I and I-b-II, scant, small; I-c-III and I-d-IV scant, large. All have smooth vestiture I-a-I and I-b-II are very susceptible to leaf spot; I-c-III I-d-IV, slightly so. Capsules when ripe are greenish black and trunk is yellowish green. Weather, rainy.

SELECTION I.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds. Wt. gm.*	*Branches*
403-F_2							
I-a-I	93.7	55	2-5	2.5×1.5	0.07	3.66	0
I-b-II	90.0	110	2-10	2.0×1.5	0.04	4.85	3
I-c-III	....	68	3-7	2.2×1.3	0.09	6.20	9
I-d-IV	101.0	50	2-6	2.3×1.5	0.09	4.44	0

Leaves of I-d-IV, scant, small; of the rest abundant, small. All have medium vestiture, greenish black capsules when ripe, and yellowish green trunk. I-d-IV is slightly susceptible to leaf spot, the rest not at all. Weather, rainy.

SELECTION I OF BRANCHING PLANT WITH FINE HAIR ON THE CAPSULES.

Plant Nos.	*Height cm.*	*Number*	*Locules*	Capsules *Size L×D cm.*	*Av. Wt. gm.*	*Seeds Wt. gm.*	*Branches*
403-F_2							
I-a-I.....	122	113	2-4	2.5×1.4	.04	4.45	10
I-b-II.....	76	65	2	2.6×0.8	.05	3.29	4
I-c-III.....	115	56	2-4	2.1×1.1	.04	2.55	9
I-d-IV.....	90	68	3-8	2.0×1.3	.06	4.50	3

All have abundant, small leaves, smooth vestiture, greenish black capsules when ripe and yellowish green trunk. I-a-I is susceptible to leaf spot, the rest are slightly so. Weather, rainy.

SELECTION I OF HAIRY SESAMUM

Plant Nos.	*Height cm.*	*Number*	*Locules*	Capsules *Size L×D cm.*	*Av. Wt. gm.*	*Seeds Wt. gm.*	*Branches*
403-F_2							
I-a-I.....	80.5	24	2-5	2.5×1.4	0.13	4.0	0

This has abundant small leaves, heavy white vestiture, whitish green capsules when ripe, and whitish green trunk. It is slightly susceptible to leaf spot. Weather, rainy.

SELECTION I.

Plant Nos.	*Height cm.*	*Number*	*Locules*	Capsules *Size L×D cm.*	*Av. Wt. gm.*	*Seeds Wt. gm.*	*Branches*
413-F_1							
I-a-I.....	190.3	131	2-4	2.0×0.9	0.07	8.67	10
I-b-II.....	186.0	114	2-4	2.2×1.0	0.08	9.12	9
I-c-III.....	190.0	112	2-4	1.8×1.2	0.08	8.05	15

I-c-III has scant small leaves; the rest abundant, small ones. All have smooth vestiture, greenish black capsules when ripe and white or yellowish green trunk. All are very susceptible to leaf spot. Weather, rainy.

Several other plants were selected, but some of them were discarded as soon as they were found to be low yielders.

All the low yielders were gathered and mixed with the common stock. After they had all been cleaned they were weighed.

The calculated yield of each variety is indicated in the following table:

College number	*Yield of plot occupied in grams.*	*Yield per acre. Kgms.*	*Yield per hectare. Kgms.*
404-F_1.....	433.125	70.15	173.25
403-F_2.....	172.380	69.75	172.30
1622-F_1.....	268.00	43.40	107.20
326-F_2.....	395.85	64.15	158.34
413-F_1.....	375.09	60.77	150.10

The computation of the yield per acre and per hektare of the above table is based upon the ground occupied by the varieties. It was stated before that they each occupied 1|400 of a hektare except 403-F_2 which is 1|1000 of a hektare.

Influence of Selection

The fact that certain selected plants produced high yields does not guarantee that they will transmit this characteristic to their progeny. This can be ascertained only by field trials.

The selected sesames were so planted that one row represents one individual plant. Precautions were taken not to mix the different plants.

This selection will not be fair to compare with the original stock as to their yield because the selections were planted at a different season and the condition of the weather may favor its development or not, so in order to have a fair comparison, a check was also planted with seeds taken from the common stock in each variety.

The aim of this work was to save the highest yielder in each variety and discard the rest as soon as they were found to be inferior.

An accurate record of the yield of each of the rows was kept. The data are given in the following tables.

Note:—The variety 413-F_1 was dropped because its selected seed was planted in dry weather and the plants did not develop well.

SELECTION II.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Ave. Wt. gm*	*Seeds. Total Wt. gm.*	*Branches*
404-F_2							
II-a-I	70.4	41	2	3.0×1.0	0.01	0.28	2
II-a-II	68.0	40	"	2.7×1.0	0.08	3.05	"
II-b-I	95.0	36	"	2.7×0.9	0.04	1.60	3
II-b-II	84.5	24	"	2.8×1.9	0.15	3.60	"
II-c-I	65.0	31	"	2.6×1.0	0.02	2.55	11
II-c-II	74.0	42	"	2.6×1.0	0.07	2.78	6
II-d-I	91.0	40	"	3.0×1.0	0.12	4.47	2
II-d-II	92.0	40	"	2.7×0.9	0.10	3.97	0
II-d-III	90.0	40	"	3.0×0.9	0.09	3.47	0
Range	65-95	24-41	2	2.6-3×.9-1.0	0.01-.12	0.28-4.47	2-11

The leaves of II-b-I, II-c-I and II-c-II are abundant and small, while those of the others are scant and small; the vestiture of the capsules is medium in all cases and all are very susceptible to leaf spot, with the exception of II-a-I, which is only slightly so; the ripe capsules are greenish black, and the trunk is yellowish green. The weather was rainy. The yield per row is as follows: a = 51.85 g.; b=49.85 g.; c = 34.53 g.; d=65.71 g.

SELECTION II.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds. Total Wt. gm.*	*Branches.*
1622-F_2							
II-aI	109	49	2-6	3.0×1.0	0.08	4.73	7
II-a-II	105	42	2-3	2.9×1.0	0.08	3.73	5
II-b-I	117	37	2-4	3.0×1.2	0.12	4.60	5
II-c-I	105	43	2-4	2.6×1.2	0.07	3.15	7
II-c-II	116	36	2-4	3.0×1.0	0.02	0.63	4
II-d-I	100	20	2-4	2.9×1.0	0.09	1.78	5
II-d-II	96	18	2-3	3.0×1.1	0.14	2.50	6

In II-a-I, II-a-II, and II-b-I the leaves are large but scant, whereas in the others they are small and scant; the vestiture of the capsules in all cases is smooth; the plants are all very susceptible to leaf spot. Their capsules when ripe are greenish black and their trunk is yellowish green. The weather was dry. The yield of one row is as follows: a=61.90 gm.; b=65.28 gm.; c=31.36 gm.; d=33.96 gm.

SELECTION II.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds, Total Wt. gm.*	*Branches*
326-F_3							
II-a-I	150.0	105	2	2.9×0.8	0.19	19.93	7
II-a-II	164.0	124	2	2.9×0.9	0.09	11.70	12
II-a-III	154.0	100	2	2.9×0.8	0.07	7.22	7
II-b-I	174.0	80	2	2.9×0.8	0.10	7.92	10
II-b-II	166.0	134	2	2.9×0.8	0.11	14.38	11
II-c-I	150.0	197	2	2.8×0.8	0.08	15.80	12
II-c-II	164.0	122	2	2.1×0.8	0.06	7.50	12
II-c-III	185.0	123	2	2.9×0.8	0.07	8.10	14
II-d-I	155.5	62	2	3.0×0.9	0.12	7.70	6
II-d-II	155.0	66	2	3.0×0.9	0.03	1.73	10

The leaves are abundant and small in II-a-I, but scant and small in all the rest; the vestiture of the capsules is smooth in all cases. All the plants are susceptible to leaf spot. Their ripe capsules are greenish black and their trunk is yellowish green. Weather, dry. The yield of one row is as follows: a=194.63 gm.; b=142.24 gm.; c=142.62 gm.; d=57.16 gm.

SELECTION II.

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds. Total Wt.*	*Branches*
403-F_3							
II-a-I	78.0	28	2-4	2.9×1.5	0.12	3.28	0
II-a-II	62.3	20	2-5	3.0×1.4	0.08	1.60	0
II-b-I	84.5	27	3-5	2.9×1.7	0.09	2.45	0
II-c-I	32.5	25	2-9	3.0×1.5	0.12	3.13	0
II-c-II	84.0	18	4-10	2.8×1.5	0.17	3.15	0
II-d-I	92.5	32	2-4	2.7×1.6	0.11	3.55	0
II-d-II	85.0	22	3-9	2.8×1.7	0.15	3.32	0

All the plants have small leaves, abundant in II-c-II and II-d-I, but scant in the rest. The capsules have medium vestiture and are greenish black. The trunk is yellowish green, and all the plants are slightly susceptible to leaf spot. Weather, rainy. The yield per row is as follows: a=34.75 gm.; b=32.75 gm.; c=58.86 gm.; d=56.87 gm.

SELECTION II OF BRANCHING PLANT WITH FINE HAIRS ON THE CAPSULES

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds. Total Wt.*	*Branches*
403-F_3							
II-a-I.....	87.9	51	2	4.2×0.9	0.11	5.83	4
II-a-II.....	83.0	52	2-4	3.0×1.2	0.11	5.70	6
II-b-I.....	92.5	70	2	3.0×0.8	0.08	5.43	6
II-b-II.....	91.0	48	2	3.0×0.8	0.09	4.33	6
II-c-I.....	101.0	50	2-6	4.0×1.0	0.11	5.32	5
II-c-II.....	103.0	30	2-4	3.0×1.3	0.11	3.45	4
II-d-I.....	110.0	46	3-4	2.8×1.2	0.11	5.20	7
II-d-II.....	98.2	41	3-4	2.3×1.1	0.11	4.63	5

The plants have abundant small leaves; the vestiture of capsules smooth, and are slightly susceptible to leaf spot. Their trunk is yellowish green and the ripe capsules are greenish black. Weather, rainy. The yield per row is as follows: a=19.98 gm.; b=41.36 gm.; c=42.97 gm.; d=84.53 gm.

SELECTION II OF HAIRY PLANT

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D cm.*	*Av. Wt. gm.*	*Seeds. Total Wt. gm.*	*Branches No.*
403-F_3							
II-a-I.....	70.5	25	2-5	2.3×1.4	0.06	1.70	0
II-a-II.....	78.5	25	3-8	2.8×1.3	0.13	3.40	0
II-a-III.....	81.2	32	2-5	2.8×1.3	0.12	4.10	0

Leaves, abundant, small; vestiture of capsules, heavily white; trunk and ripe capsules are whitish green; all are only slightly susceptible to leaf spot. Weather, rainy. Yield for this row is 45.23 gm.

SELECTION OF LOCULES

Plant Nos.	*Height cm.*	Capsules *Number*	*Locules*	*Size L×D. cm*	*Ave. Wt.gm.*	*Seeds. Total Wt. gm.*	*Branches No.*
403-F_3							
I-a-I (5).....	93.0	28	3-6	2.6×1.9	0.06	1.80	0
I-a-I (6).....	77.0	19	3-9	2.5×1.6	0.12	2.28	0
I-a-I (7).....	67.5	30	3-5	2.7×1.4	0.09	2.70	0
I-a-I (8).....	69.0	33	4-9	2.6×1.5	0.12	4.17	0
I-a-II (8).....	59.0	18	3-7	3.0×1.6	0.12	2.28	0
I-a-I (9).....	68.0	18	4-8	2.6×1.8	0.12	2.20	0
I-a-II (9).....	67.0	20	3-9	3.0×1.4	0.12	2.40	0
I-a-II (10)....	57.0	28	2-7	2.3×1.2	0.15	4.33	0

The numbers in parenthesis attached to the plant Nos. indicate the number of locules per capsule of the parent. Thus I-a-I (5) means that in that row the seeds were taken from a group of plants having five-locular capsules. The leaves are scant and small in all except I-a-I (9) and I-a-II (9), which have them abundant and small. The vestiture of capsule is medium in all, and they are slightly susceptible to leaf spot. The capsules are greenish black while the trunk is yellowish green. Weather, rainy. Yield per row: I-a-I (5)=35.52 gm.; I-a-I (6)=52.97; I-a-I (7)=27.30 g.; I-a-II (8) and

I-a-I (8)=27.75 g.; I-a-I (9) and I-a-II (9)=27.50 g.; I-a-I (10)=13.38.

It is worth noting that the groups did not come true to the original types of capsules: Thus I-a-I (5) produced plants having capsules of from 3 to 6 locules.

In selection II tables it seems the highest yielders among the selection of the different varieties were 404-F_2 II-d-IV, 403-F_3 II-d-IV, 1622-F_2 II-b-I, and 326-F_3 II-a-I.

Knowing the area occupied by these high yielders we can easily turn the production into acres and hektares as calculated in the following table:

College number of plants	*Yield of one row in gms.*	*Yield per acre in kgs.*	*Yield per hektare in kgs.*
404-F_2-II-d-IV	65.71	85.09	210.27
403-F_3-II-d-IV (Fine hair)	84.53	109.46	270.496
1622-F_2-II-b-I	65.28	84.09	208.9
326-F_3-II-a-I	194.63	215.72	532.82

I have stated before that during the culture of selections, a check was also planted in order to have a fair comparison.

The check was planted on the same kind of soil where the selected plants were planted. Every check was planted in 1|200 of an acre.

YIELD OBTAINED FROM THE CHECK

College number of plants	*Yield occupied by crop. (grams)*	*Yield per acre (Kgms.)*	*Yield per hektare (Kgms.)*
404-F_2	890.85	72.1	178.17
403-F_3	622.34	50.45	124.45
1622-F_2	1000.0	80.97	200.00
326-F_3	1710.05	134.42	342.01

Having recorded the yield of the original stock, the check and the selection let us group their yields on the following table to see the effect of selection upon the yield.

College number of Plants	404	403-F_1	1622	326-F_1
Yield per ha. of the original stock	*Kgms.* 173.25	*Kgms.* 172.30	*Kgms.* 107.2	*Kgms.* 158.34
Yield per ha. of the check	*Kgms.* 178.17	*Kgms.* 124.45	*Kgms.* 200.00	*Kgms.* 342.01
Yield per ha. of the selected plants	*Kgms.* 210.27	*Kgms.* 270.496	*Kgms.* 208.9	*Kgms.* 532.82
Gain of the selected over the original stock	*Kgms.* 37.02	*Kgms.* 98.196	*Kgms.* 101.7	*Kgms.* 374.56
Gain of the selected over the check	*Kgms.* 32.10	*Kgms.* 146.046	*Kgms.* 8.9	*Kgms.* 190.81

From the result obtained in the above table we can conclude that selection increased the yield over the common stock. A very marked improvement of this crop appears to have been made as a result of saving only the best individuals and discarding the poor and unpromising strains.

About the beginning of the year 1914 the third culture of the selection was begun, but on account of the hot and very dry weather the plants did not develop well and therefore no data were taken from this third culture.

Inheritance of Characters by Selection

It has been observed that during the first culture numerous variations occurred. Taken together they may be divided into two classes. First gradual variation that seemed to have been due directly to slight differences in environment. Second, sudden variations, "mutations" that are rare and that appeared as a very wide variation. Mutants appeared in the second culture.

The ordinary number of locules of the sesamum capsules ranged from 2-4. But here and there in the field among the plants of the second generation there appeared exceptional individuals that bore far above this number. I have counted as many as ten locules in one capsule. In the harvest I separated the capsules and divided them into groups according to the number of locules in each capsule disregarding the individuality of the plant. I planted each group separately with the hope of finding individuals of pure strain as to increased number of locules. The attempt to do this was not a success for the groups did not come true to the original types of capsule. Plants that were expected to bear seven locules bore five or three, and the same was true of the other plants

Another attempt was made to isolate pure breeds. As I have stated before the seeds I obtained from the Agronomy Department came from the ordinary heterogeneous field stock.

The plants that grew therefrom presented a number of widely differing characteristics. Some individuals appeared to be more pubescent than the others. The fine-haired varieties were more profusely branching and had other definitely marked characteristics. In this strain the number of locules was more constant than in the others. The number was two in almost all the capsules, in rare cases only were there three.

The medium and hairy varieties were less branched as a rule. In these two strains, there is a wide variation in the number of locules, ranging from 2 to 10. Selections were made to isolate the following three strains:

1. Very pubescent strain.
2. Medium haired strain.
3. Fine haired strain.

I saved the seeds separately taking care not to mix one kind with another. The result was that in the second generation I was able to isolate these three different strains, pure and distinct from each other.

Self-Fertilization of Sesamum Plants

Beside the selection that was made upon the different varieties, bagging was practised to try whether they can be self-fertilized.

The bagging was done in all the different varieties. I was successful in obtaining seeds from 404 and 403-F_1 only. With the others I could not get results on account of the heavy rains that occurred, the papers being broken so that insects had an opportunity to get inside.

The capsules were gathered from those that were successful and were dried. After they had been dried they were planted in separate cultures.

During their culture, much care was taken, and they grew well and bore fruits.

This experiment shows that the two varieties which have been tried can be self-fertilized and perhaps the same thing can be done to the rest of the varieties, thus opening the possibility of fixing still other selected forms that may present desirable characters.

Importance of Selection

It is very important to keep the variety pure because uniform types of plants are thus secured. Observation has shown that this crop is badly mixed so that low average yields are obtained. "Like begets like" and a farmer can expect to get only what he sows. The isolation of pure strains is a matter of the utmost importance in the culculture of sesame.

The farmer himself can easily accomplish much by means of selection. A little time must be devoted before harvest to gathering some of the plants which seem to suit his choice. The selected plants should be separated from the general stock. The selection must be continued until a marked improvement is noticed in his crop. This process of selection can be applied to any field of sesame. The method is easy, and anybody can do it, not only for his own cultures, but for the sale of improved seed.

Points in Selection

Uniformity.

The general time of harvesting is when the capsules are beginning to open. At this time some of them are not fully matured and many are lost before the general harvest is completed. This indicates the need of a more uniform maturing of the capsules of sesamum.

Hardiness.

This plant is not so strong as some other plants. A little wind injures it, and heavy winds are very destructive. However, there are plants which show great resistance to typhoons and other similar adverse condition. By selecting those individuals we should get strains with stronger stems, which will survive the conditions which seriously injure the common type.

Yield.

It has already been observed that any crop which is a high yielder is mostly a favorite of the grower and without this characteristic the plant is useless to the farmer. The importance of the method of selection as bearing on this characteristic is paramount.

Summary

1. The yield of sesamum can be increased by selection in the field and by growing the selected seeds in separate plots.

2. The sports which appeared in 403-F_1, such as the hairy and the smooth forms, can easily be bred true.

3. With the character of high yielding which is found in certain plants of 403-F_1 can be correlated branchiness, fineness of the hair, and shape of the capsules, in all of which they differ from the common stock.

4. The varieties 404 and 403-F_1 can be self-fertilized.

5. Sesamum in common cultures in the Philippines needs to be improved by selection, as regards strength of stem, immunity to disease, uniformity of type, resistance to drought, and brevity of crop period; and above all else, as to productiveness.

REFERENCES

1. Le Sésame de L'Extrême-Orient, by Ph. Eberhardt.
2. El cultivo del Sesamo en las Islas Filipinas. (Bull. No. 14.)
3. Origin of the Cultivated Plants, by DeCandolle.
4. Commercial Product of India, by Watt.
5. Egyptian Agriculture, Vol. II.
6. The Philippine Agriculturist and Forester, Vol. I, No. 10.
7. Experiment Station Record, Vol. XIII.

Caution in Use of Fertilizers

The use of fertilizers is often regarded as the most essential and characteristic feature of the practice of scientific agriculture. Courses of agricultural instruction usually give much more attention to this than to any other part of the subject. There are various books, and good books, devoted to the subject of fertilizers and their use. Every general treatment of one of our crops devotes much attention to this phase of its proper culture. In one book on the coconut, there are nearly 150 pages devoted to fertilizers. The planter is continually urged to use them, and the favorable experience of those who have done so is constantly invoked for his guidance.

There is no question as to the general possibility of securing by means of fertilizers greater yields than will be obtained without them. There is likewise no question as to the profits which can usually be obtained by the judicious use of fertilizers. Neither is there any doubt that such manures as are produced on the farm can be used to good purpose as fertilizers, and that failure so to use them is always very wasteful.

Nevertheless, the dogmatic treatment which the subject often receives in editorials and appeals to the farmer, and in many other places, is thoroughly misleading. There are two general reasons why this is so. In the first place, the evidence is not what it seems to be. It is the almost universal custom outside of well conducted experiment stations to apply fertilizers to the land, to observe the increase in production of crops, and to construe this as measuring the profit. It needs no consideration to show that increased yield and increased profit are by no means the same thing. Before a profit from the use of fertilizers can be computed, the farmer must, of course, take into account the cost of fertilizer, and the cost of operations incidental to its use, such as for instance harrowing it into the ground. In careful work there must still be considered interest on the money tied up, the future value of fertilizers still remaining in the soil, and the value, independently of fertilization, of treatment given incidentally to the use of the fertilizer. It is rare indeed to find a farmer who keeps his books in such a way that he knows at all accurately what the application of fertilizers has cost him. Even the manure of his own stock is rarely applied without some expense, whether for fencing, herding, hauling, or otherwise.

There is no kind of experimentation which requires more perfect understanding of the subject and knowledge of possible sources of error, and care in guarding against unreliable results, than does the testing of the value of fertilizers. In such experiments, when carried on as field or plot cultures, the soil takes the place of the chemist's labor-

atory apparatus, and the soil is complex far beyond anything in the chemist's laboratory. The gross chemical composition of the soil is easily determined and is reasonably stable. But the individual constituents as chemical compounds fluctuate from day to day. These fluctuations are partly understood and are partly under control.

It is generally believed by those who are not professionally acquainted with the subject, that it is possible to determine by chemical analysis of the soil what fertilizers, and how much of each, can profitably be applied to it. This is sometimes the case, but it is a rare one. Soil analysis may reveal such scarcity of nitrogen, or potash, or phosphorus that one may safely conclude without any other evidence, that one of these substances will produce such results as are sure to be profitable. Much more commonly this is not the case. The soil analysis is likely to indicate what experimental tests are most likely to be worth while, and these experimental tests will then be a guide to the use of fertilizers on the farm.

There are many reasons why the analysis alone is not a safe guide for the application of fertilizers. It has already been mentioned that the elements in the soil are constantly re-arranging themselves. What is present in the soil is of value to the farmer only as his crops take it up and use it. The crops take all of their food from the soil in solution in water. Any compound in the soil is available when it is dissolved and unavailable when it is not dissolved. The extent to which the food materials in the soil enter into solution depends obviously on the amount of water present. In the soil of most farms and of the best coconut plantations there is moving water which brings into the soil about the trees food material from other places. However poor chemical analysis may show such soil to be, the trees are well nourished, and the use of fertilizers is very likely to be unprofitable. The application of fertilizers, guided by chemical analysis, but without taking into account the water supply of the soil, is, therefore, irrational.

Crops differ considerably in the demands which they make upon the soil. Some of them have deep root systems, and can accordingly take up food at depths down even as far as two meters. Others have the roots very close to the surface; for those, deep-seated stores of food are available only as the substances come toward the surface of the soil, in solution. Some plants are conspicuous for the quantity of single food element which they require. These peculiarities of individual plants are always taken into account in applying fertilizers to crops of temperate lands. In the tropics it is customary to attempt this; but as a matter of fact our knowledge of the requirements of most of the staple tropical crops is altogether inadequate in this respect. We have no such analyses, that is, no such large number of analyses, of coconut trees, or their leaves, or nuts, or of the abaca plant or fiber, that any man can say with confidence that either of these plants needs to take up any particular amount or any particular per cent of any single mineral food. It is sometimes possible by analysis of the plant, or the marketable product of the plant of various temperate crops, to ascertain that some mineral food is not present in normal amount, and, therefore, to decide that this food could be profitably applied as a fertilizer. The knowledge obtained by analysis of the plant is in such cases a very much safer guide to the use of fertilizers than is the suggestion afforded by chemical analysis of the soil.

The second objection to the evidence at hand demanding the use of fertilizers on our crops is the fact that there is not taken sufficient account of the extreme variability of local conditions. The world's study of fertilizers has been made in Europe and the United States. In the central United States observations made in one spot are usually valid ten miles away, often one hundred miles away, or even more. The soils and climate have been so perfectly studied that the intelligent farmers can easily know whether or not the results obtained at his state experiment station are immediately applicable to his own farm. In the Philippines there is an astounding local diversity of soil. At this College it is difficult to secure a square tract of one hectar on which soil conditions are so uniform that one part furnishes a valid check for all others. The variable climatic factor is water. Its variations are not so intensely local as those of the soil except as the water varies with the difference in the soil. Still there are places in the Philippines where at sea level the rainfall at points 20 Kilometers apart varies in the ratio of fully 3 to 1.

Under such conditions the individual planter should take experience in other places as a guide to experiments, but can not without risk take it as a guide to practice on a large scale.

With all of this, I do not intend to discourage the use of fertilizers. Their proper use would be one of the greatest possible improvements in the agriculture of most parts of these islands. There are provinces in which the staple industry will be improved by their judicious use more than in any other one way. There are probably few farmers in the whole Archipelago who could not increase their profits if they know how to use fertilizers to the best advantage. But while they do not know what fertilizers are most needed, what forms can best be secured, when and how they should be applied, and what results can reasonably be expected from their use, the time for their widespread application has not arrived. Their use on a large scale, with confident expectation of profit, would merely result in the majority of cases in disappointment, and in the establishment of prejudices, which would be very difficult to remove, against their further employment.

In securing the adoption of any improvement in agriculture, haste must be made slowly. This is true when those who give advice are sure of their ground. When experimentation itself has not passed the earlier stages, it is not time to make haste at all. The time is always here to encourage the farmer to experiment when he does this understanding that he is making experiments, and that it is not in the nature of an experiment that the results should be known in advance. He can be told with confidence that it is possible for him to use fertilizers with profit. He can also be told how to find out how to do this. In many places, it is now possible for the government, through field representatives of its bureaus, to help the farmer plan his experiment, so that it will be most likely to show how to use fertilizers profitably.

The most rapid possible advance in the use of fertilizers in these islands will be by enrolling the farmers as experimenters, by helping them to institute and properly control their experiments, and by taking care that they understand that failure with one fertilizer and in one place is no more reason for discouragement than success with another fertilizer and in another place is a reason for the general adoption of locally successful methods.

Finally, it must be understood that many experiments prove nothing whatever, and that this is especially true of experiments made by those who are not especially expert in such work. So long ago that every individual concerned has now left the Philippines, I saw an experiment made on the fertilization of the coconut by means of ashes. These ashes were applied to two paralle. rows of trees running east and weste During the succeeding few months thd trees of the south row, which had received the ashes, exceeded the other row remarkably in production. This fact was duly reported as a most instructive demonstration of the value of ashes as coconut fertilizers.

The fact was that the trees of the south row were an average of 3 or 4 meters higher than those of the north row, and that they were at all times correspondingly thriftier. The experiment included the winter months when the south row shaded the north one to a considerable extent. But if the experiment had been properly started, the trees of the two rows exactly alike and equally exposed to all outside conditions except the fertilizers, it would still have been true that the application of the fertilizers could have had no appreciable effect on the production during the time the experiment lasted.

There have been reported to me the results of two other experiments on the fertilization of coconut in these islands. In both cases, the supposed improvement was observed before it possibly could have been due to the fertilizers applied. In all of these cases the treatment was probably beneficial, so that good happened to result from the accident; but the observed results were none the less accidental.

Men are not so quick to tell about their mistakes as about their successes, and it is probable that at various times fertilizers have been applied, and decided to be valueless or injurious; and that the subsequent thrifty growth and production,—for which the fertilizers were really responsible,—have been construed as evidence of recovery.

The first essential in any scientific agriculture is the understanding of the ways of the plant.

E. B. C.

The Philippine Agriculturist and Forester

Twenty-five centavos a Copy. Two pesos a year

Foreign Subscription 1.50 dollars a year

Published by the Student Body of The Philippine College of Agriculture

Entered at the post-office at Los Baños, Laguna, as second class mail matter

Vol. III **1914** **No. 3**

MANUEL ROXAS, *Editor-in-Chief*
JOSE T. MIRASOL, JOSE QUERUBIN DACANAY, *Assistant Editors*
BIENVENIDO MA. GONZALEZ, *Business Manager*
BLAS C. VELEZ, *Advertising Manager*
DOMINGO B. PAGUIRIGAN, *Circulation Manager*
ADDRESS ALL COMMUNICATIONS TO THE BUSINESS MANAGER, LOS BAÑOS, LAGUNA

Student Body Activities

The Plow

Through the plow, the second annual of the College of Agriculture, the Student Body has again presented itself to the public. The publication came out on the day of the Commencement of the University. The general tone is calculated to convince the public of the utility of the institution and to explain the primal importance of agriculture and forestry in the development of the country. There is not much graphical work in the annual, but the students have at least succeeded in expressing themselves in their own words. A panoramic view of the college may be found; an exposition of forestry in the Philippines; the introduction of thirty-two new rangers and young agriculturists; an explanation of the present standing of the institution, the improvements of the past year, an exposition of the prospects and work of the graduates of the college; illustrations of the many organizations of the college; a presentation of the year's athletic activities; a roster of the alumni; and some suggestive glimpses of the native jokeland. It is, as a whole, a great improvement over that of last year. It is wholly managed and worked out by the students and is a credit to the Student Body.

Election

At the meeting of the Student Body last March, an election of the officers for the first semester of 1914-1915 was held. The result is as follows:

President.....LEOPOLDO B. UICHANCO
Vice-President.LEOPOLDO MENDOZA
Secretary.....MARIANO E. GUTIERREZ
Treasurer.....VICENTE ALDABA

Alumni Organization

On the evening of the Commencement of the University, a meeting of the alumni of the College of Agriculture was held at Manila on the occasion of a dinner given in honor of the Dean. The organization of an alumni association was resolved upon and Mr. B. M. Gonzalez, '13, was elected temporary president, and Mr. Nemesio B. Mendiola, '14, temporary secretary-treasurer. A fund was raised immediately to finance the society. A committee to draft the constitution was appointed. It has been suggested that each class select a secretary to act as a medium of communication between the class and the association secretary. It is planned that an annual meeting be held to discuss agricultural problems and questions, and that an annual visit be made to the College.

The Influence of Fertilizer on the Growth and Production of Sugar-Cane

By Silvestre Asuncion

Thesis presented for graduation from the College of Agriculture, No. 7.

The proper use of fertilizers on agricultural crops is a pressing problem among Filipino farmers. Most of the agricultural soils in the Philippines are rich. Whether or not fertilizers will pay on these Philippine soils is a problem, the solution of which can only be reached by field experiments. The richest soil will, in time, become exhausted if it is continuously cropped. Cane, in its growth, is a gross feeder, so that for its continuous cultivation on the same land there must also be continuous fertilization. Ross, who made many analyses of cane in Louisana, found that with each ton of cane removed, leaving the tops and leaves in the field, there were also removed 3.4 pounds of nitrogen, 1.48 pounds of phosphoric acid, and 2.17 pounds of potash. This means that a crop of 30 tons will remove about 102 pounds of nitrogen, 45 pounds of phosphoric acid, and 65 pounds of potash. The farmers of the Philippines as yet have no realization of the great quantity of these valuable ingredients that are continually being removed from the soil with their crops.

It has been found by the Hawaiian Experiment Station (Sugar Planters' Association) that phosphoric acid if applied alone does not give any marked increase in the yield, but in combination with other elements, such as potash, the production is markedly augmented. In my experiments here, the rate of growth of the phosphoric acid plot was very low and the production of cane was also very low, even lower than in the check plot.

In many places in the world it has been found that lime improves the physical texture of heavy soils. The liming of soils in the Philippines, among ordinary farmers, is practically unknown. It can undoubtedly be used here in many places to great advantage. Clay soils so heavy as to be practically non-cultivable to the Filipino might after liming be workable with his tools. In fact, it may be stated in general that the use of fertilizers is unknown to the Filipino farmer. Even in Negros, where sugar cane is extensively cultivated, fertilizers are not generally employed by the native farmers.

Walker, of the Philippine Bureau of Science, in his study of sugar cane in Negros, says: "The great majority of planters in Negros at the present time pay absolutely no attention to fertilizing the soil, but reap crop after crop with apparently no thought for the future." But this is also true in any part of the islands. He adds: "In some of the less productive districts, such as Silay and parts of Bago and La Carlota, diminishing yields are beginning to force this subject to their attention, and some attempts are being made toward improving the soil, chiefly by means of animal manure."

However, a deficiency of plant food is not always the cause of poor returns. Insufficiency of water may be the cause, and irrigation is then demanded. Excessive amounts of water may also cause failure, in which case drainage is needed. Lack of porosity, a common feature of clay soils, may seriously impede root development. In this last case,

the application of fertilizers may mean great waste. In every case local conditions should be carefully studied to determine the needs of any soil. Nothing is to be gained by the application of food materials already present in sufficient quantities. Excessive amounts may even check the growth. Eckart, of the Hawaiian Sugar Planters' Association, in his report for 1903, describes an experiment in which two plots were used, each plot receiving 200 pounds of potash and 200 pounds of phosphoric acid the difference in fertilization being in the chemical form of the material applied. In one plot 200 pounds of phosphoric acid as acid phosphate, and 200 pounds of potash as sulphate were applied. In the second plot, 200 pounds of phosphoric acid as ground phosphate rock, and 200 pounds of potash as sulphate, were used. He found that the first plot gave a gain of 364 pounds of sugar while the second plot gave a gain of only 1.543 pounds of sugar. The difference in the yield, he says, is doubtless due to the use of a more insoluble form of phosphoric acid in one case, causing less injury to the roots of the cane than the more soluble and also acid form used in the other case.

In extensive experiments conducted by the Hawaiian Sugar Planters' Association, it was found that potash applied alone as potassium sulphate gave apparently no results, but when applied with nitrogen a very large gain, as high as 46 per cent, resulted. In the year 1897 Tieman found that this combination gave as high as 24 per cent. In 1903 Eckart found that in the application of phosphoric acid alone there was a loss of 15 per cent in the yield, and potash applied also alone caused the loss of 4 per cent. When both these fertilizers were combined, the experimenter obtained a gain of 17 per cent. Eckart also found that the combination of nitrogen and phosphoric acid gave an increased production of sugar amounting to 6,577 pounds. Phosphoric acid alone increased the yield by 1,392 pounds; nitrogen alone, 4,168 pounds per acre, and the two, when applied together in equal weights, instead of a resulting gain equal to the sum of the two figures, this was increased by 1,017 pounds per acre, using a Rose Bamboo cane for the experiment. In the Lahaina variety the combined application resulted in an increase of 3,989 pounds of sugar per acre. Tieman, of Egypt, said, in regard to this combination:

"The employment of nitrogen in the case of sugar cane brings about an apparently luxurious growth or vegetation, but a weak, unresisting cane stem which is laid low by the first storm, and is generally of little value for manufacturing purposes. On the other hand, if the supply of nitrogen is combined with that of phosphoric acid, then one obtains a powerful, vigorous, resisting cane stem and a ripe sugar cane for the factory. By the action of the phosphoric acid the degree of ripeness and the sugar are specially favorably influenced."

Calculating the sum of the gains following the application of the respective elements, individually, Eckart found the value of the different combinations as follows:

	Pounds.
N+K	6,068
N+P	5,368
K+P	4,284
N+K+P	7,864

Tieman, of Egypt, has also found that the fully manured plots gave a yield of 76 metric tons cane per hectare, while the unmanured plots gave a yield of only 61 metric tons of cane per hectare there being a gain of 24 per cent in the former instance.

PARTS OF THE CANE TO BE PLANTED

It was found by Tieman in his experiments in Egypt in 1897 that planting the lowest portion of the cane stem as seed gave the poorest results. The top part yielded an excess of 3,500 kilograms of cane over that of the middle portion, and 17,500 kilograms of cut cane over the lowest portion; this was per hectare and without application of manures. In regard to this matter, he gives the following recommendations:

It is not correct to plant out the richest portions of the lower stem but on the contrary one should select the most germinative part of the stem. The young upper part of the stem, owing to the collecting of the juice in it, has physiologically a greater vitality than the middle or lower parts. The stem nodes are still fresh and develop germination more quickly and this has its influence on the whole subsequent period of growth.

In the following year he conducted an experiment to test the effect of full manuring, selection, and proper distance of planting as compared with the old Arabic methods. Plots I and II were equally fertilized, while plot III remained unmanured. It was found that with an interval of 1 meter with single and 1.2 meters with double rows of cuttings, the yield was distinctly better than in the Arabic arrangement with intervals of only 0.7 meter. The quantitative results of this experiment are shown as follows:

Plot	*Kilograms of cane per hectare*	*Pounds of cane per acre*
I.....	79,546	70,935
II.....	83,132	74,133
III.....	56,937	50,774

In 1888 to 1889 D José Sanchez Miranda conducted an experiment in Negros in which he tested the effect of greater distances in planting. In plot I, planted at the rate of 83,333 tops to the hectare, the distance between tops was 0.15 meter. In plot II, planted at the rate of 36,363 tops per hectare, the distance between the rows was 1.10 meters and the distance between tops 0.25 meter. The production of cane was as follows: Plot I, 1,557 kilograms of cane; and Plot II, 1,754 kilograms of cane. The result was in favor of the greatest distances.

EXPERIMENT AT LOS BAÑOS, LUZON

In connection with this work, there were planned and carried out a large number of experiments on the Agricultural College grounds relating to the planting and fertilization of cane. These experiments involved the handling of 22 separate plots. Due to over five months delay in the application of any fertilizer and to the following of this by a severe drought with no possibility of irrigation, the value of many of the results hoped for was completely vitiated. In spite of these untoward circumstances, the experiments were carried through to conclusion and careful data were kept throughout. The delay in fertilizing, followed by drought, makes any conclusion regarding the effects of fertilization in connection with these experiments both uncertain and contradictory. However, out of all the work done in these various plots there are several instructive results to be noted, the truth of which would be quite unaffected by any of the unfavorable conditions surrounding these experiments. For instance, the effect of liming heavy soils was here very clearly demonstrated. The plot heavily limed gave canes of uniformly greater circumference than did a half-limed plot. Measurements of the yield of these plots taken April 14 gave for the heavily-limed area at the rate of 21,800 kilograms of cane per hectare, while the half-limed areas yielded at the rate of only 13,480 kilograms per hectare.

The plots in which the ordinary Philippine method of planting was followed not only gave a poor total yield of cane at the rate of 12,340 kilograms of cane per hectare, but the circumference of the canes was less than in other plots. The ordinary Philippine method of planting is very similar to the Arab method, the cuttings in both methods being planted closely together and the distances between rows being small. This close planting presents always the following disadvantages: (1) Suckering is comparatively less than in plots with plants somewhat farther apart. This was shown by counting the number of suckers per hill or stool. One plot planted by the Philippine method gave an average of 8 or 9 suckers; another plot, with wider spacings, gave 17.1 suckers. Also, in the latter case the average circumference of the canes was greater. (2) The canes were smaller, but taller when planted by the Philippine method and, therefore, would not resist strong winds. During such winds they often lodged. Lodged canes are difficult to handle in harvesting, and the sap in such cane is usually more watery.

In another experiment one plot was planted with entire canes placed end to end in the rows. In a corresponding plot the canes were cut into pieces in the usual manner. In the former, the germination was very low, only about 40 per cent, while in the latter case of top cuttings the germination ran as high as 98 per cent. During some seasons Philippine lands are left unplanted for lack of tops for seed cane. In such cases it would, of course, be advisable to use entire canes in spite of some loss of sugar occasioned thereby.

Recommendations

There are some general recommendations that might follow from experimental work such as was contemplated and partly carried out here:

1. On lands that are liable to become completely dried out in times of drought, it is absolutely necessary to have some provision for irrigation in order to be able to obtain any distinct gains from fertilization.

2. Fertilizers should be applied as early as possible in the life of the plant, beginning preferably at the time of planting.

3. Top cutting should be used as seed cane and should be planted from 30 centimeters to 60 centimeters apart in the rows and the rows should be 0.7 meter to 1 meter apart, AT LEAST.

4. Entire canes, even with their far lower percentage of germination, may sometimes be substituted for top cuttings in planting, provided the entire canes are planted end to end. Entire canes should never be cut into pieces and planted at the same distances as top cuttings.

5. Heavily fertilized fields are likely to suffer far more from drought than if entirely unfertilized, so that dressings of fertilizer on lands subject to drought should never be heavy at any one application.

6. An application of lime may be very beneficial for heavy soils.

Current Literature

A study of some of the factors influencing the efficiency of Bordeaux mixture by Lon. A. Hawkins(1) shows that it is possible to make a Bordeaux mixture in which the copper settles out slowly by adding concentrated calcium hydroxide to diluted copper sulphate solution, or vice versa, provided the mixture is sufficiently agitated. The necessary agitation, however, is so great that it is likely to be impracticable without the use of power. Experiments with various substances, expected to make the copper adhere to the plants sprayed, show that the best results were obtained by the use of two pounds of rosin-fish-oil soap to fifty gallons of the mixture. Of the substances tested, ground glue was second in value; rosin-fish-oil soap with one pound to fifty gallons third; and fish-oil soap alone, fourth. Ferrous sulphate had no value.

Bulletin No. 4 of the Department of Agriculture of Ceylon gives the yield of some Hevea trees at Heneratgoda, with other information on the same plants. One tree 37 years old, with a girth of 117.5 inches, yielded 45 lbs., 3.5 oz. of rubber in 76 days, an average of just over 9.5 oz. a day. No other tree approached this remarkable yield. The effect of spacing, which is a composite effect of the illumination, and of the space available to the roots, is shown in one of the plantations where the average girth of ten outside trees is 76.27 inches, while the average girth of ten trees in the next row inside is 44.02 inches. Isolated trees, and others so placed that there was a good opportunity for the development of a wide-spreading branch system, usually give notably large yields of rubber. There is not, however, any close relation between the size of the trunk and the yield of large trees. The most productive tree had roots the size of a lead pencil 55 feet from the base of the trunk. In one case, a root was found 80 feet from the trunk of a tree.

(1) U. S. Department of Agriculture, Bureau of Plant Industry, Bull. No. 265.

Bulletin 5 of the same department deals with manuring and shading of cacao. With regard to shade, it is shown that at Heneratgoda trees without shade are comparatively backward in growth, and a large per cent do not survive. The necessity of shade with any crop depends so entirely upon moisture conditions, both in the soil and the atmosphere, that data of this kind have a chiefly local value.

The figures given on the effect of manuring are based on experiments begun in 1906 and continued until 1911. The results are tabulated below. The plot used as control, that is No. 37, was itself a remarkable productive one, giving decidedly the best yield of any of the six unfertilized plots which might have been used for comparison. While no figures are presented to show the cost of the fertilizers used, it is obvious that some of those employed proved exceedingly profitable. Thus the use of 250 lbs. of ammonium sulphate, or 107 lbs. of potassium chloride, resulted in an increased yield amounting to 3.6 cwt. of cured cacao.

Cacao Manurial Experiments at Peradeniya, 1906-1912.

No. of Plot.	*Manure Applied Description.*	*Quantity applied per acre per annum till 1911*	*Average good Pods per year from 1906-1912.*	*Average Excess over best Unmanured Plot, i. e., No. 37.*	*Proportion taking Plot 37 as Unity.*	*Average equivalent Cwt. of Cured Cacao.*
37	Best unmanured taken as Control Plot.	.....	3,327	.....	.....	2.6
111	Ammonium sulphate	250 lb.	7,738	4,411	2.3	6.0
94A	Potassium chloride	107 lb.	7,700*	4,373	2.3	6.0
94B	Potassium sulphate	125 lb.	7,548*	4,221	2.2	5.8
98	Fish	5 cwt.	7,387	4,060	2.2	5.7
107	Basic slag Castor cake	250 lb. 833 lb.	7,175	3,848	2.1	5.5
96B	Potassium sulphate Precipitated phosphate	100 lb. 163 lb.	6,654*	3,327	2.0	5.2
96A	Concentrated superphosphate	141 lb.	6,622*	3,295	1.9	5.0
9	Bone dust	5 cwt.	6,594	3,267	1.9	5.0
95B	Ground nut cake	896 lb.	6,558*	3,131	1.9	5.0
108	Groundnut cake Potassium sulphate	714 lb. 100 lb.	6,488	3,161	1.9	5.0
3	Lime 2 tons in 1903; Crotalaria sown, pruned, and forked in	.....	6,359	3,032	1.9	4.9
100	Castor cake	833 lb.	6,177	2,850	1.8	4.8
95A	Sodium nitrate	400 lb.	6,126*	2,799	1.8	4.8
7	Basic slag Ammonium sulphate	5 cwt. 200 lb.	5,851	2,524	1.7	4.5
8	Kainit	6 cwt.	5,708	2,381	1.7	4.4
101	Basic slag Potassium sulphate	250 lb. 100 lb.	5,695	2,368	1.7	4.4
6	Trenched buried debris with 10 cwt. lime, ground not forked	.....	5,514	2,187	1.6	4.2
110	Basic slag with lime and twigs	250 lb.	5,472	2,145	1.6	4.2
4	Cattle manure forked in round the trees.	10 tons.	5,288	1,961	1.5	4.0
109	Nitrate of Potash	114 lb.	4,900	1,573	1.4	3.8
99	Bloodmeal	400 lb.	4,877	1,550	1.4	3.8
5	Trenched and buried debris with 10 cwt. lime and forked round	.....	4,726	1,399	1.4	3.6

*Calculated to the equivalent quantity per acre, these plots being half acre, the others one acre.